The Imitative Mind

Development, Evolution, and Brain Bases

Edited by
Andrew N. Meltzoff and
Wolfgang Prinz

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2 Imitation and imitation recognition: Functional use in preverbal infants and nonverbal children with autism

Jacqueline Nadel

Introduction

Two options in developmental studies: search for precursors or search for adaptive behaviors

Early imitation is currently a major topic for developmentalists. They investigate its developmental role and elaborate models concerning the processes through which imitation may serve as a determinant building block for later cognitive and social development. Piaget (1945) consecrated this tradition, focusing on deferred imitation as a predictor of representational capacities. Recently, Meltzoff and Gopnik (1993) proposed the fascinating hypothesis that early imitation provides the means to elaborate human properties which will lead to a theory of the human mind. They see imitation as a machine to extract similarities, a *like-me mechanism* through which a neonate is supposed to draw equivalences between what she sees and what she does and vice versa, thus forming the concept of *like-me entities.*

While the predictive power of emerging imitative capacities is emphasized, and the cascading effect of their development is modeled, little attention is given to the functional use of these capacities by the developing child, in her everyday life. This information is crucial because the functional use of a behavior informs us about main developmental pathways, and especially about how the infant builds herself. Moreover, changes in functional use and transitory functional use of behaviors stress the nonlinear aspect of epigenesis, the flexibility of brain development and may be of help to understand the link between early behaviors of modern infants and ancestral behaviors of the human species in an evolutionary perspective.

My first aim in this chapter will be to highlight why a functionalist perspective is crucial for the study of imitation. I will show that the preverbal child uses imitation to initiate social exchanges and to respond to others' initiations, in short to communicate. In the second section of the chapter, I will analyze what notion of imitation and imitation detection is needed to account for the use of imitation as nonverbal language, and how far this "language" implies intentionality in self and other. Detection and monitoring of intentionality may be out of reach for the very young infant and also for some low-functioning children with autism. Finally, I will emphasize the developmental role of imitation as a semantic foundation for language development.

Imitation and the developing child

Preverbal children use imitation to communicate

In a series of experiments, we explored when and how children use imitation. To this aim, our studies were conducted in an interactive context without having an adult present. Dyads or triads of acquainted peer infants (who were not close friends) met in a setting furnished with two or three identical sets often attractive objects. The children were free to use the objects for solitary play, or in social games involving identical or different objects for cooperative or imitative purpose. Having filmed more than 150 children of different ages, we clearly found a predominant use of imitation during social exchanges after eighteen months with a peak of use around thirty months (Nadel, 1986). These imitations presented several characteristic features: they followed conventional rules, they were reciprocal, and they involved referential use of objects. Let us detail how. In all triads and dyads, two "routines" invariably preceded the start of an imitative episode. One routine was for an infant to offer (or show) to another infant an object similar to the one s/he held. The partner most often took the object and imitated its use. Sometimes however s/he refused the initiator's suggestion. In these cases the initiator left the object s/he held and turned to imitate the partner's ongoing activity. An alternative routine was for an infant to

directly start imitating another infant, using an identical object in the same way, without any request of the imitatee. The imitatee soon noticed being imitated and further proposed new instrumental activities to the imitator. From this we can conclude that primary conventional rules monitor and control imitative social exchanges, and regulate turn-taking and role-switching. Such a regulation is very efficient, even in triadic meetings where there are only two roles for three persons: in these cases indeed the number of times children imitated and the number of times they were imitated remained highly and positively correlated (Nadel-Brulfert & Baudonniere, 1982). Obviously the children found it as interesting to be an imitator as to be a model. Further studies with repeated meetings of the same partners led us to understand that imitations act like primary scripts: they convey shared attention to the same topic through a similar use of similar objects as co-referents (Nadel, Guerini, Peze, & Rivet, 1999).

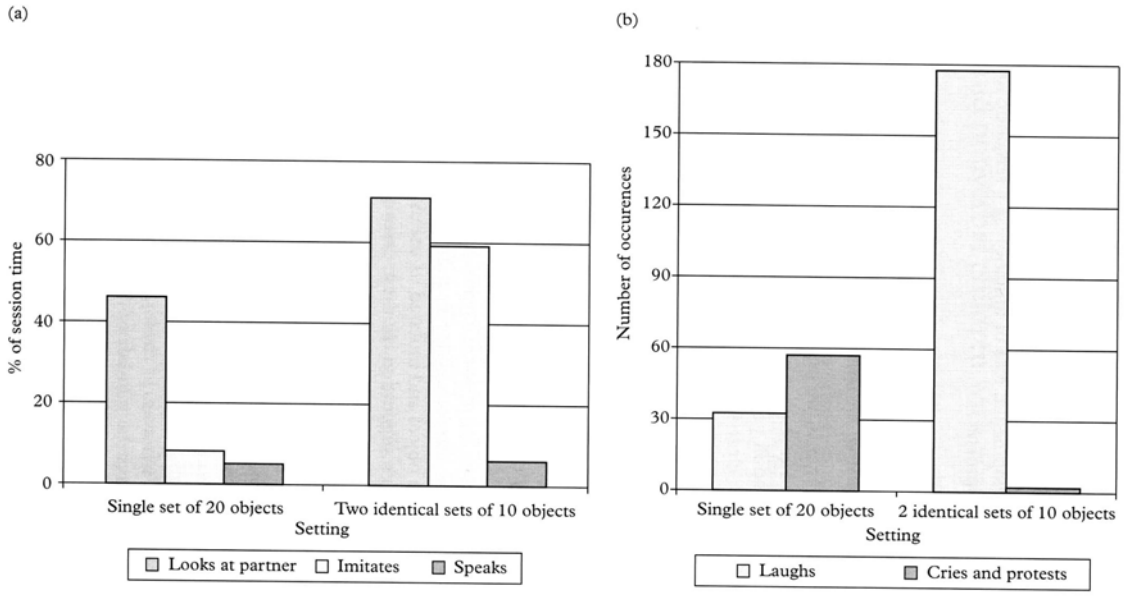

Figure 2.1. (a) Attention according to instrumental imitation availability (b) Emotions according to instrumental imitation availability

In sum, we found that when children use imitation in their social exchanges, they can take turns, switch roles, share topics and apply conventional rules, thus, they can communicate. Later observations in naturalistic settings like preschool playgrounds persuaded us that our results reflect an effective everyday use of imitation as a way to communicate. Eckerman's data in naturalistic settings (Eckerman, 1993) corroborated these informal observations.

Our next finding was that the communicative function of imitation is transitory and disappears when language is mastered. This was demonstrated in an experiment in which dyads of two-year-olds and dyads of three-year-olds met either in a setting with two identical sets often objects or in a setting with a single set of twenty objects. Results did not show any setting effect for the three-year-olds who, regardless of setting, identical or single objects for cooperative but not imitative purposes (Nadel & Fontaine, 1989). By contrast, there was a strong setting effect for the two-year-olds, who significantly gazed less at their partners, engaged less frequently and for shorter durations in interactive episodes and laughed far less when they met in a setting with single objects rather than in a setting with identical objects (see Fig. 2.1). Interestingly, the preverbal children did not imitate their partners during the meeting with single objects. Indeed in this setting they could not synchronize their instrumental activity with the imitatee's, since there was only one object of each kind for two children. Of course the children had the opportunity to imitate body movements which do not involve objects, but we did not observe such imitations. It was as if two similar objects were needed to

afford imitation, just as specific objects *afford* specific actions. This is not to say that all the actions imitated were already part of the imitator's repertoire.

The analysis of hundreds of imitations resulted in the distinction of two categories of matching: matching of familiar instrumental activities such as <put the sunglasses on nose>, and matching of a new procedural use of a familiar object, such as <put the sunglasses around the ears like earrings>, or <use the umbrella as a stick to conduct a concert>, or <walk with an upside-down chair above head> etc. (see Fig. 2.2). Strikingly, preverbal infants imitated novel actions as quickly and easily as familiar ones, and achieved an almost perfect temporal synchronism if an imperfect morphological matching. The temporal synchronism, I should add, was also monitored by the imitatee, who often slowed down the ongoing instrumental

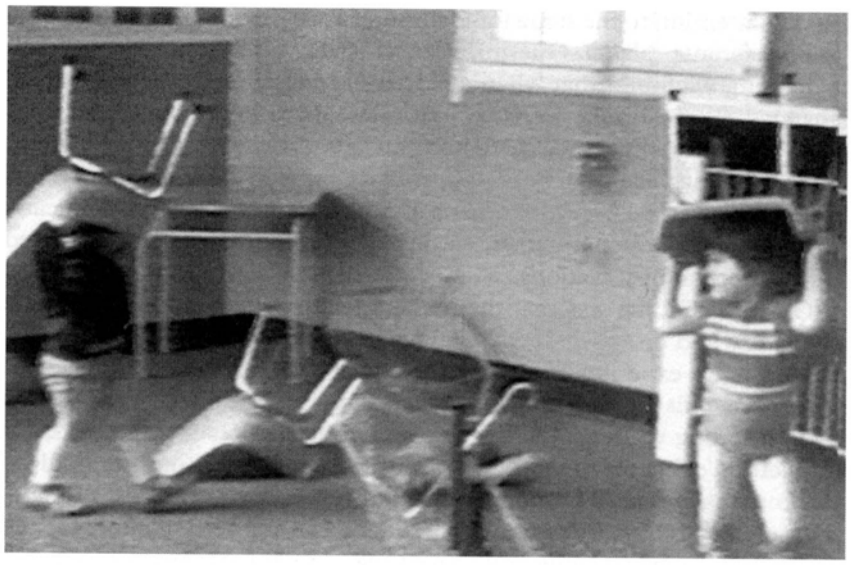

Figure 2.2. During imitative exchanges, infants inhibit learned schemes and imitate unexpected use of objects

Now the question is to know which are the prerequisites for this amazing ballet between two or three children who alternate roles, take turns, coordinate their activities in time and in topic and follow conventional rules (see Fig. 2.3 for a summary). Is this ballet the sophisticated achievement of early developing socio-cognitive capacities? Is it the origin of more sophisticated communicative capacities?

The imitative language and the developing mind

The imitative language: a functional achievement of the "like-me mechanism "?

Maybe the more striking aspect of the imitative language is the communicative value of similarity (you do like me and I do like you). Obviously it shares common features with the innate *like-me mechanism* hypothesized by Meltzoff and Gopnik (1993) as mapping out (cross-modal) equivalences between *"movements-as-felt and the movements [• • •] performed by others"* (1993: 336) from birth on. Persons are *like-me entities* in so far as they can do like me (when they imitate me) and I can do like them (when I imitate them).

Similarly, in our description of the imitative system, imitator and imi-tatee have interchangeable roles acting out the same intention: being alike (Nadel, 1986).

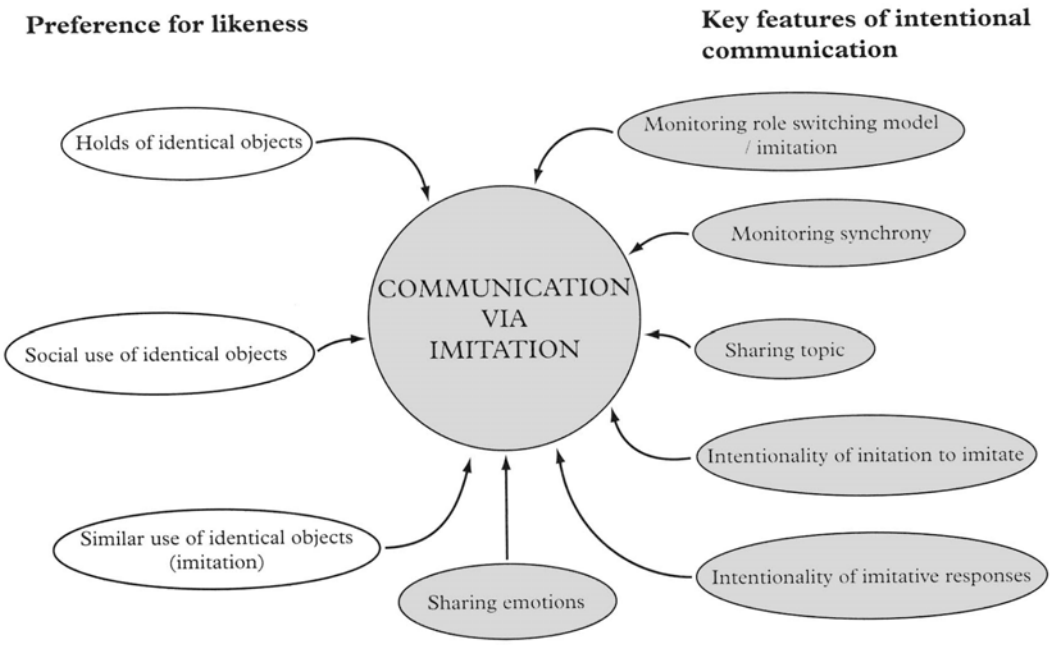

Figure 2.3. The imitative language

Given this, it is very tempting to propose that the imitative system of communication is the functional achievement of the *like-me mechanism.* As a starting-point stage, and before the effective use of the imitative system, the *like-me mechanism* would generate implicit awareness of being imitated and unintentional imitation. Indeed, in the description of the *like-me mechanism,* imitation and imitation recognition are tightly linked as two facets of the same innate capacity to test structural similarities between self and other persons. Neonates are thus supposed to be not only imitators but also imitation recognizers. To date, however, if neonatal imitation is well documented, it is more difficult to assume that neonates have an implicit awareness of being imitated. Let us consider these elements more precisely.

It is now well established that neonates are imitators. The pioneer work by Maratos (1973) and the seminal studies published by Meltzoff and Moore (1977, 1983) opened new avenues which led to a spurt of exciting and converging researches in the field (Heimann, this volume; Fontaine, 1984; Kugiumutzakis, 1993). Newborns are not only able to imitate facial movements such as tongue protrusion, or mouth opening, they also imitate facial expressions (Field, Wbodson, Greenberg, & Cohen, 1982), eye blinking, and vocal sounds (Kugiumutzakis, 1993, 1999). Whenever newborns produce imitation, they produce social contingency. The enthusiastic reaction of parents when they see their infant imitating a tongue protrusion or an eye blinking is a very convincing index of the fact that imitation is probably the unique signal of social contingency available for parents at birth.

Since newborns are imitators, we could intuitively reason that they are also imitation recognizers. This intuitive reasoning is based on the postulate that the detection of matched behavior (detection of an equivalence between what we do and what we see) requires the same capacity that the production of matched behavior (production of an equivalence between what we see and what we do). There is a large body of psychological and neuroimaging experiments that have demonstrated that perception of action shares some common neural and cognitive mechanisms with action generation, action simulation, action recognition and, to some extent, action imitation (Decety, this volume; for a review, see Decety & Grezes, 1999). On the basis of these data, neuroscientists have proposed the concept of shared motor representations (Georgieff & Jeannerod, 1998). How this concept relates to neonatal imitation is of major interest. Indeed, primary imitations may be viewed as wired perceptual-motor coupling (Decety & Ingvar, 1990; Jeannerod, 1997), resulting from the activation of neural centers controlling movements, which Rizzolatti and colleagues metaphorically name a low-level resonance mechanism (Rizzolatti, Fadiga, Fogassi, & Gallese, this volume). Maybe such a simple mechanism can also explain early recognition

of being imitated (or at least early detection of redundant information between what is done and what is seen). However there is an important difference in the social consequences of the two phenomena: early imitation can unintentionally convey a message of social contingency (/ *act like you),* while imitation recognition will deliver a message of social contingency if and only if the infant *signals* that she has recognized being imitated and thus that she has attributed intentional imitation to the imitator (7 *notice that you act like me).* This would lead me to predict later empirical evidence of imitation recognition than of imitation. And as a matter of fact, we have no demonstration that neonates detect imitation. The imitative newborn, however, is sensitive to temporal contingency between events (Blass, Ganchrow & Steiner, 1984), and after a few weeks, infants can form expectancies for social contingency.

Early detection of nonimitative and imitative contingency

Six-week-old infants react negatively to an experimental violation of social responsiveness by the mother posing a still face during a live interaction (Murray & Trevarthen, 1985; Tronick *et* a/., 1978), or in a televised face-to-face interaction (Gusella, Muir, & Tronick, 1988; see Muir & Nadel, 1998 for a review). Similarly they withdraw when they are presented with a smiling and communicative but noncontingent mother (Murray & Trevarthen, 1985; Nadel *et al.,* 1999).' Since mere temporal contingency is detected so early, structural similarities plus temporal contingency should be detected even more easily.

Of course, it is possible, as suggested by Meltzoff and Moore (1999), that there is a precocious implicit awareness of being imitated although there is no clear evidence of early specific responses to imitation. Implicit awareness is supposed to be captured by the increase of attention to the imitator. Stern (1977) and also Trevarthen and Hubley (1978) pointed to the early use of imitation by mothers as a strategy to attract and maintain their infants' attention. With older infants, Field (1977) found more gaze to mother when the mother imitated her 32-week-old than when she interacted in another way. Does this reflect imitation recognition? Specific social responses to maternal imitation would be more convincing indices than gaze.

To explore this question, we used a televised face-to-face design with mothers and their two-month-olds. Mothers were asked to get in touch and keep contact with their infants via a TV closed-circuit device. The face-to-face interaction lasted two minutes. Our first results with thirteen dyads show that ten of the thirteen infants imitated their mother's facial expressions, head postures, and hand movements. Eleven mothers imitated their infant, some of them very frequently, others scarcely. All eleven infants who were imitated reacted at some of the maternal imitations: we gathered 35 responses for 76 imitations. 40 per cent of the responses were focal looks at the mother. Only three infants used uniquely these very basic and nonspecific responses. The other 60 per cent of responses were social signals associating look at the mother with smile (n = 18) and/or tonguing or vocalizing (n = 18). Six of the eleven infants displayed such social signals whenever their mother imitated them. These results suggest that two-month-olds perceive their being imitated as a contingent social behavior to which they give a social answer (Nadel, 2000). Whether they detect a difference between imitative behaviors and other social behaviors of their mother deserves further examination, but it is a likely assumption if we follow Rochat and Striano (1999) who report that two-month-olds are sensitive to the form of their own action.

With three-month-olds, Uzgiris, Vase, and Benson (1984) found maternal imitation in 20 per cent of free interactive episodes, which is less than what we found with younger infants. It is reasonable to assume that the televised device that we used is a strong elicitor of eye-to-eye contact and is thus particularly propitious to imitative episodes. Uzgiris *et al.* report 12 per cent of two-round episodes where either the infant or the mother imitated in return. These data suggest that imitating in return is possibly the first specific response to imitation, which can be found at three months and even earlier (one of our two-month-olds showed imitations in return). This suggestion is strengthened by recent findings demonstrating that infants after three months are capable of differentiating between a live video feed-back of their movements and a delayed feed-back of their own moving legs. The three-month-olds preferred the on-line feed-back while the five-month-olds were more interested in the deferred feed-back (Bahrick & Watson, 1985; Rochat and Morgan, 1995; Schmuckler, 1996). This interesting finding suggests that five-month-olds have already formed primary representation of the bodily self

and orient preferentially their attention toward external stimuli rather than toward overlapping self-produced ones (see Rochat, this volume). This may encourage one to predict that signaling imitation recognition would start being effective in young infants around five months as a phenomenon that Trevarthen *et al.* beautifully name "a translation between the affor-dances of proprioception and *alteroception"* (Trevarthen, Kokkinaki, and Fiamenghi, 1999: 136).

Specific responses signaling imitation recognition

To date, there is no valid demonstration of imitation awareness before fourteen months. Indeed, using a cross-target method, Meltzoff (1990) demonstrated that fourteen-month-olds prefer an imitative adult to a nonimitative adult, even when both behave contingently. The contingent imitator received more gaze and smile, and more testing behaviors aimed at checking whether the adult was intentionally imitating them. In more naturalistic conditions, Asendorpf, Werkentin, and Baudonniere (1996) showed that most but not all eighteen-month-olds reciprocate imitation, which may account for an explicit signal of imitation recognition. Similarly Eckerman (1993) demonstrated that being imitated prompts further imitation of the peer imitator in eighteen- to 24-month-olds.

In sum, we have drawn the picture of a very young infant who is able not only to detect noncontingency but also to expect contingent behavior from close partners and who is able to produce imitations long before she demonstrates explicit imitation recognition. Even if she has an implicit awareness of being imitated, she does not signal it and this awareness cannot be taken into account by others. She is thus able to take turns via imitation but not to turn roles. Some low-functioning children with autism appear to present the same pattern.

Imitation in low-functioning children with autism

When we read the literature concerning autism, it seems to be already established that children with autism have imitative impairments. Clinical researchers however mostly use imitation in their everyday practice to get in touch and maintain contact with those children, and they report that many of them are frequent imitators and/or appreciate being imitated. As a matter of fact, whether or not autistic children have specific imitative impairments is currently a controversial topic among psychopathologists. The three main models aimed at accounting for the core developmental symptoms of autism are in striking disagreement on this matter. In Hobson's (1986) emotional theory of autism, imitative impairments are a secondary consequence of primary emotional disabilities. Baron-Cohen, Leslie, and Frith (1985) propose a simulation of autism in which pragmatic capacities related to the construction of a theory of mind are deficient, but primary social capacities (including immediate imitation) are intact, given the cognitive developmental level of the child. In contrast, Rogers and Pennington (1991) provide a model of the potential cascade effects on social development of a primary deficit in motor imitation from the beginnings of life. Rogers recently wrote that "studies published since 1991 have not disconfirmed Rogers and Pennington's hypothesis" (1999: 278). Rogers' argument relies on the fact that several studies have theorized (Donald, 1991) or documented (Dawson & Adams, 1984; Nadel & Peze, 1993, Tiegerman & Primavera, 1984) a linkage between imitation and other social skills. However this does not validate the hypothesis of a primary and specific impairment of imitative capacities. Studies comparing autistic children and mentally deficient children matched on mental age give contradictory findings: some report significantly lower performances of children with autism, while others cannot differentiate autistic performances from MA matched ones (Charman & Baron-Cohen, 1994; Whiten & Brown, 1999). Other authors found imitation impairments in some autistic subgroups but not in all (Adrien *et al,* 1987).

An interesting new perspective is to focus the concern on the description of imitative abilities and disabilities in autism rather than on the demonstration of the specificity and primacy of possible imitative impairments. In fact, several authors have found imitative deficits in different developmental disorders, including Down's Syndrome and other forms of mental retardation. If we follow Smith and Bryson (1994), imitation may be diagnostic of basic problems in the domain of action development rather than a basic

impairment *per se*. In addition, we do not know enough about motor productions in children with autism, except that they are poor and infrequent, as poor and infrequent as imitations are. For instance, in three follow-ups, we found that imitative performance was at a higher level than spontaneous motor production (Nadel & Peze, 1992).

Contradictory results also reflect the heterogeneity of the procedures used (clinical evaluations of imitative level, imitative scores in neu-ropsychological tasks, experimental designs, interactive designs) and the absence of a clear definition of the type of imitation explored: symbolic versus concrete, immediate versus deferred, simple versus complex, to which we can add imitation of action versus imitation of goal (Byrne & Russon, 1998), and spontaneous versus induced imitation. Studies generally focus on induced imitation rather than on spontaneous imitations which take place in a social context and may have a communicative meaning. It follows that careful investigations of the use of imitation by children with autism are very infrequent. For instance, there is only a handful of studies using an interactive design to investigate imitation, although most researchers in the field now consider imitation as a main component of social cognition (cf. Rogers, 1999; Rogers, Bennetto, McEvoy, & Pennington, 1996; Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Meltzoff & Moore, 1999).

Our experiments, all conducted in a context of free social interaction, have shown that nonverbal children with autism - even very low-functioning children - mostly produce spontaneous imitations when meeting a nonautistic child (Nadel & Peze, 1993) or a playful adult (Escalona, Nadel, Field, & Lundy, in press). The imitations produced concern either familiar or novel gestures, they are simple gestural matching or imitations of goal-directed actions involving objects. They are a good predictor of social capacities (Nadel & Peze, 1993). Do all these imitative children also recognize being imitated?

Implicit and explicit recognition of being imitated in low-functioning children with autism

Children with autism are said to be impaired in imitation but able to recognize being imitated. This classical claim, however, is difficult to validate in the absence of a clear definition of what is called imitation recognition. Dawson and Adams (1984), and Tiegerman and Primavera (1981, 1984) found an increase of positive attention to the experimenter and an increase of object manipulation when the experimenter imitates the autistic child's procedural use of a similar object. Does this account for imitation recognition? Even if the children improved their social behavior, they did not address any explicit signal of imitation recognition to their partners, nor did they show any specific response to imitation compared to other social behaviors. We face the same kind of problem with our two-month-olds who look and smile to their imitative mother just the way they smile and look to their nonimitative mother.

In search of a reliable index of imitation recognition, we conducted a study where 25 low-functioning children with autism, all occasional or frequent imitators, met an unfamiliar adult who imitated systematically during three minutes any of their instrumental and stereotypic gestures as well as their meaningless or meaningful postures. To explore their capacity to recognize that they are imitated, we measured their gaze behavior during the experimenter's imitation. Alternations of gaze to their own object and gaze to the experimenter's activity with the identical object were considered as an index of imitation recognition (see Fig. 2.4). We found that only twelve out of the 25 children used such gaze strategies. Some of the others sometimes looked briefly at the adult as by chance, others did not seem to notice the experimenter's activity (Nadel & Bottai, 1999). These findings are in agreement with developmental data: like very young infants, some low-functioning children with autism are able to imitate (at least very simple gestures), but they do not show specific signals of imitation recognition. It remains of course to precisely define which kind of imitation and which kind of imitation recognition were assessed.

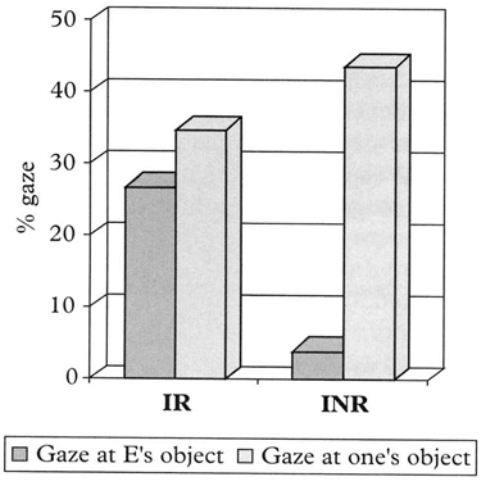

Figure 2.4. Gaze behaviors of children with autism facing an imitative adult. *IR* = children classified, as imitation recognizers. *INR* = children classified as non-recognizers.

Let us try to distinguish several levels of imitation and imitation recognition. At a low level of functioning, children with autism, like new-borns, may produce perception-action coupling and imitate movements that they see without an explicit intention to do so. Furthermore, intentional imitation may involve no awareness that the imitated behavior is itself intentional. In contrast, at a higher level, imitative behavior is informed by the intention to do as the others intend to do. An even higher level is distinguished by Roessler (1999), when imitation is informed by the intention to do as the others intend for me to do (communicative imitation).

Imitation recognition also deserves several levels. A very simple level of imitation recognition does not imply attribution to the imitator an intention to imitate. Higher levels of recognition imply such an attribution and require understanding the imitator as an intentional agent planning to imitate your behavior. Hence the behavioral strategies to test the imitator (Meltzoff, 1995). Finally, we might talk of recognition of communicative imitation when the model understands the partner's imitation as caused by the intention to conform to what the model intends him/her to do. We found this kind of imitation recognition around 24 months.

In a recent study (Nadel, Field, & Potier, 2000), we explored other behaviors which may account for active testing strategies. 27 children with autism aged three to seven, with different cognitive levels, were shown a large variety of movements and actions which they were either requested to imitate or not. Alternately some of their movements and actions were emphatically imitated. All the children with autism were able to imitate something. For imitation recognition, we coded six possible responses: *shows no reaction; looks at the experimenter; looks at the experimenter plus gives a social signal* (smile, touch, offering); *alternates looks to the experimenter's object and looks to his/her object; tests the experimenter's intention to imitate* (changes action and/or object while looking at the experimenter); *tests the experimenter's intention to imitate what the child wants her to imitate* (proposes weird uses of objects, makes faces while performing, etc.). We found that only five children were able to recognize intentional communicative imitation, while the majority of children showed social signals which may account for imitation recognition without an understanding of the imitator's intention to imitate.

The imitative language: intentional primitives

Imitation recognition is a necessary condition for the infant to understand the other's imitation as intentional, but it is not sufficient to form expectancies for intentional imitation as a general feature of human beings (i.e. *here is somebody like me,* in Meltzoff and Gopnik's (1993) terms). Comparing the contingency preference of two-year-old infants and of MA matched children with autism, Gergely and Watson (1999) recently reported an interesting finding: the two-year-olds preferred an imitative contingency of

their hand movements to a perfect computer-generated contingency, while children with autism preferred the perfect contingency.

My contention is that healthy infants were more interested in imperfect contingency because it met their expectancies for agency. They had already formed generalized expectancies for human social behaviors which include an awareness of the fact that social contingency is never perfect (Bigelow, 1999). What is important in the contingent imitation is not the quality of imitation but the human intentionality that imitation conveys. A computer-generated perfect contingency does not meet expectancies for human intentional contingency. Therefore, only children who cannot form this kind of expectancies will prefer the more perfect matching. Although they can perceive and expect social contingency after prior exposure, I shall argue, children with autism cannot expect contingency as a general property of human behavior.

One test of this claim is the reaction of low-functioning and nonverbal children with autism to a modified version of the Still Face paradigm (Nadel *et al.* 2000). In this pilot study, each child met a stranger during a nine-minute session composed of 3 three-minute episodes including a first Still Face episode (SF1) followed by an Imitative Interaction, followed by a second Still Face episode (SF2), acted by a stranger. The eight children ignored the stranger and did not show much (or even not any) concern about her still behavior during Still Face 1. Six minutes later, however, during Still Face 2, the children showed contingency awareness and reacted to the violation of contingency. Indeed, the strong differences in autistic social behaviors that were found between the two Still Face conditions suggest that the adult had to prove to be a human being before some social expectancies can take place.

This contrasts strongly with the reactions of three-year-olds who refused from the start to stay alone in the room with the still stranger. Even five- to six-month-old babies are able to form a generalized expectancy that strangers will initially engage them in reciprocal interactions. When the stranger failed to do so in a noncontingent episode, visual attention and positive facial expression decreased (Hains & Muir, 1996). Similarly, Reyes, Striano, and Rochat (1998) showed that six-month-olds explored the still stranger more compared to a lively stranger. This result accounts for precocious expectancies about human behavior: infants as young as six months expect that human beings - even strangers - will behave in a particular way. Our results suggest that low-functioning children with autism do not form these generalized expectancies, even if they can expect imitative contingency after prior exposure to an imitative partner.

Some consequences follow. Indeed, if a child is able to develop expectancies for imitation, s/he is also able to monitor her/his being imitated by others. S/he is not only capable of recognizing when s/he is imitated and indicating that s/he understands imitation as a social signal, but s/he also can plan being imitated and signal to the partner her/his intention/desire to be imitated. S/he thus knows that the partner is able to understand an incitation to imitate. The socio-cognitive revolution of the nine-month-old, as Tomasello (1999) calls the remarkable social changes which occur when children start interacting about objects and understanding persons as agents, provides the means of an intentional use of imitation, of an explicit awareness of being imitated, and of generalized expectancies for intentional imitation. Why does the imitative system appear so late in the course of the second year? Maybe now it is time to analyze further the capacities required to take part as an imitator in the imitative system of communication.

The observation of a partner performing a familiar action with the appropriate object requires one to code the actions performed and plan complex imitations. However, as said earlier (see pp. 45-6 and Fig. 2.2), when they communicate via imitation, the infants imitated not only familiar actions but also a novel, unconventional and often funny use of familiar objects. They were thus able to inhibit the activation of learned actions and automatic schemes afforded by the familiar objects, and, following step by step the new motor procedure they saw, perform a novel action without an understanding of the imitatee's goal. Note that this looks exactly opposite to the results reported by Meltzoff (1995) at about the same age. In Meltzoff's experiment, eighteen-month-olds violated literal imitation when the modeling procedure failed to attend the end. I do not think, however, that these two reports are contradictory. In Meltzoff's study, the infants were able to activate a learned scheme at a program level and inhibit motor imitation at the action level (Byrne & Russon, 1998). In our

studies, infants could inhibit the expected goal so as to perform literal imitation of weird actions, against cultural learning. In both cases the infants had to understand the model's intention and to use imitation accordingly: in Meltzoff's experiment, the adult intended to achieve a given action, in our experiments the peer partner intended to monitor the infant's activity in an unexpected way.

To use intentional imitation efficiently in social exchanges, the imitator has another intentional task to fulfill: s/he has to coordinate turn-taking and role-switching with the partner, sometimes agreeing with the role of imitator that the partner assigns to her/him, and sometimes refusing the role and suggesting to the model, through the routine of offering an identical object, to imitate her/him in return.

Final comments

Imitation as a language: a developmental role for a transitory function?

Imitation, imitation monitoring and public recognition of being imitated allow preverbal children to communicate with preverbal children during long-lasting episodes - a performance that they cannot achieve with other communicative means. The imitative language however, as a late achievement of the *like-me mechanism,* needs some cognitive and meta-cognitive ingredients such as the capacities to attribute intentions to the imitator, to plan and induce imitative behaviors, to understand incitation to imitate, to negotiate turn-taking and role-switching. These capacities are not to be found before eighteen months, and some low-functioning children with autism do not seem to benefit from (or at least to exploit) such capacities. If we add that the use of the imitative language is restricted to preverbal children addressing preverbal children and that it is a transitory system that vanishes when verbal language is mastered, we could then question whether or not this language has a developmental role.

Via imitation, infants can sustain long social exchanges and share intentions that can be fulfilled here and now. It is a powerful language which begins when the infant is around eighteen months, evolves in complex and coded combinations of imitating and being imitated throughout the two following years, and disappears when verbal language is mastered. Such a developmental curve suggests that imitative language prepares verbal language. Via imitation and recognition/monitoring of being imitated, young imitative minds can have common topics based on similar actions with similar objects, and they can take conversational turns. Via imitation and recognition/monitoring of being imitated, older imitative minds can share pretend play and memories of pretend events (Nadel *et al.,* 1999) and they can see themselves as part of a shared project.

Infants can do all this without words, on the basis of their felt likeli-ness, especially when they perform similar actions with similar objects. Turn-taking, topic-sharing, understanding the other's intentions, negotiating shared goals through codes and routines, all these features of verbal language are prepared by the use of the imitative system. The imitative language can therefore be seen as a semantic foundation for verbal language, in the way in which Donald (1991) describes the mimetic stage of humankind, compared to the stage of spoken language. Like the mimetic stage, the imitative stage of communication adds a representational dimension to imitation. It allows children to represent events, roles, and pretend goals and actions. And overall, it is a way to give an effective meaning to self and others' intentionality in motor actions. It is a self-sufficient, sophisticated tool for thought without verbal language. Most fascinating is that it is a transitory communicative system. Soon after the mastery of words, children will start avoiding imitation as mockery, thus indicating that imitation no longer sub-serves communication nor does it scaffold the understanding of intentionality.

Note

1 Rochat, Neisser, and Marian (1998) did not replicate Murray and Trevarthen's results. However they studied older infants and overall they compared the infants' responses to two different episodes of maternal communication, while Murray and Trevarthen, and Nadel *et al.* compared the same maternal episode, once on line and the second deferred.

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